University of Bahrain
College of Information Technology
Department of Computer Engineering

Control Systems
ITCE 470

[redacted]

QUIZ #1

Name [redacted] ID [redacted] Date 01-10-2015

1. An automatic control system adjusts a control valve to maintain the level of water in a tank. [2 marks]

   a. What is the **controlled** variable in the system? Level of water. ✓

   b. What is the **control** variable in the system? [redacted] The flow of water

2. **Indicate whether the following are open-loop or closed-loop control systems [2 marks]**

   Example : A domestic washing machine (O.L.)

   a. Maintenance of normal body temperature of a human being. C.L ✓

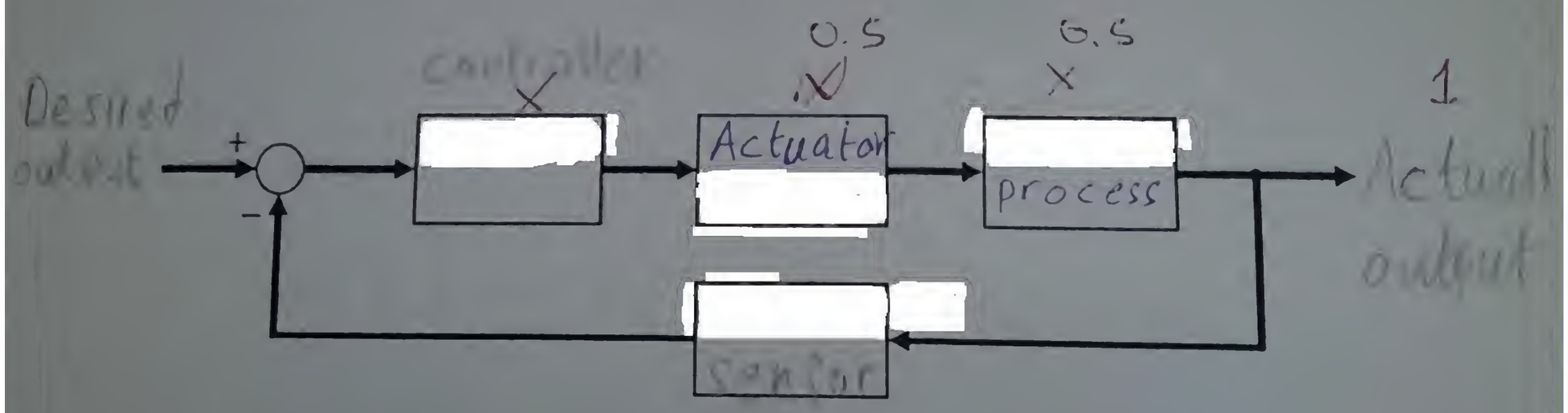
   b. A timed irrigation sprinkler system O.L. ✓

   c. The room air-conditioner. C.L. ✓

   d. A toaster O.L ✓

   2

3. ***The diagram below shows a closed-loop control system. Put the following in the right place: Actuator, Sensor, Process, Controller, Desired Output, Actual Output [3 marks]***



0.5 ✓ 0.5 ✗ controller ✗ 1

4. **Write the three main objectives of a good control systems [3 marks]**

1- stability. ✓
2- Transient response. ✓
3- Good stedy state. ✓

3

Name _____ ID _____ Date 21-10-2015

1. The linear motion of an automobile including the drag force may be described by

$$m\dot{v} + bv = f$$

where v is the velocity (m/sec), f is the input force (N) transmitted from the engine, m=500 Kg, and b=100 N sec/m.

Determine the time response $v(t)$ of the system to the impulse force f=1000δ(t) and zero initial condition [5 marks]

TABLE 2.1 Laplace transform table

Item no.	$f(t)$	$F(s)$
1.	$\delta(t)$	1
2.	$u(t)$	$\frac{1}{s}$
3.	$tu(t)$	$\frac{1}{s^2}$
4.	$t^n u(t)$	$\frac{n!}{s^n + 1}$
5.	$e^{-at}u(t)$	$\frac{1}{s + a}$
6.	$\sin \omega t u(t)$	$\frac{\omega}{s^2 + \omega^2}$
7.	$\cos \omega t u(t)$	$\frac{s}{s^2 + \omega^2}$

$m\dot{v} + bv = f$ $\quad V(t) = ??$

$F = 1000\,\delta(t)$

$ms\,V(s) + b\,V(s) = F(s)$ $\quad F(s) = 1000$

$$V(s) = \frac{F(s)}{ms + b} = \frac{1000}{500s + 100} = \frac{10}{5s + 1} = \frac{10/5}{s + 1/5} = \frac{2}{s + 1/5}$$

$V(t) = 2e^{-1/5\,t}\,u(t)$.

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QUIZ #3

Name_____ ID_____ Date 20-10-15

1. A RC circuit has the following transfer function

$$\frac{V(s)}{R(s)} = \frac{2}{10s + 4}$$

For a step input r(t)=10 V, how long it takes to the output of the RC circuit to reach 63% of its final (steady-state) value? [5 marks]

2. Given the transfer function

$$G(s) = \frac{12}{48s^2 + 24s + 96}$$

a. *Sketch qualitatively* the output response to a step of size 3 [3 marks]. *Indicate explicitly* the steady state value of the output.

b. Determine the 2% Ts [2 marks]

1) $\frac{V(s)}{R(s)} = \frac{2}{10s+4}$, $r(t) = 10V$, $T_{1\%} = \frac{4.6}{\zeta\omega_n}$

$\tau = \frac{10}{4} = 2.55$

2) $G(s) = \frac{12/48}{\frac{48}{48}s^2 + \frac{24}{48}s + \frac{96}{48}} = \frac{0.25}{s^2 + 0.5s + 2}$

$T(s) = \frac{K\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2} \Rightarrow \frac{K}{\frac{s^2}{\omega_n^2} + \frac{2\zeta}{\omega_n}s + 1}$

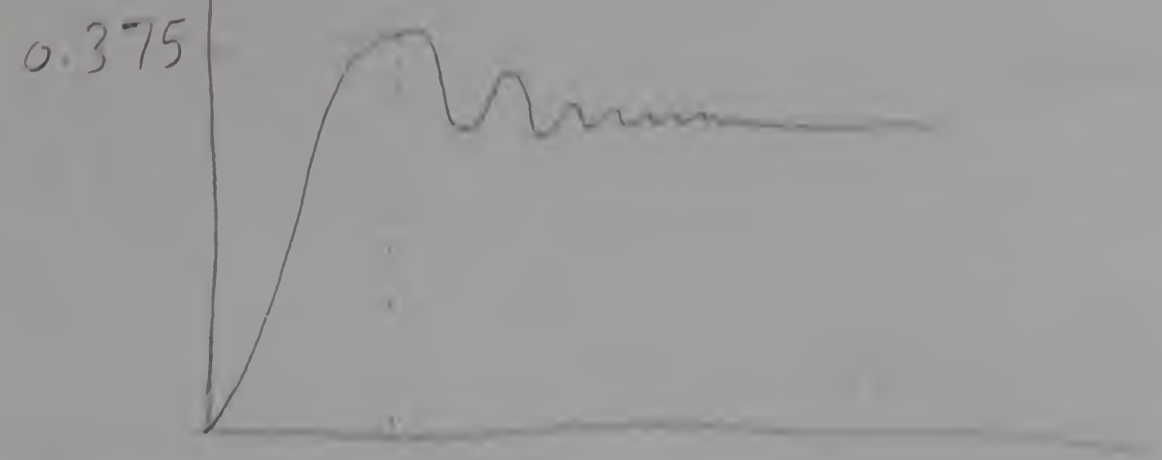
$2\zeta\omega_n = 0.5$, $\omega_n = \sqrt{2} \simeq 1.41$

$\zeta = \frac{0.5}{2\omega_n} \Rightarrow \frac{0.5}{2 \times 1.41} = 0.17$ ← underdamped

$K\omega_n^2 = 0.25 \Rightarrow K = \frac{0.25}{\omega_n^2} = \frac{0.25}{2} = 0.125$

$Kr_0 = 0.125 \times 3 = 0.375$

$T_s = \frac{4}{\zeta\omega_n} = \frac{4}{0.17 \times 1.41} = 16.6s$



QUIZ #4

Name _____ ID _____ Date 22-11-2015

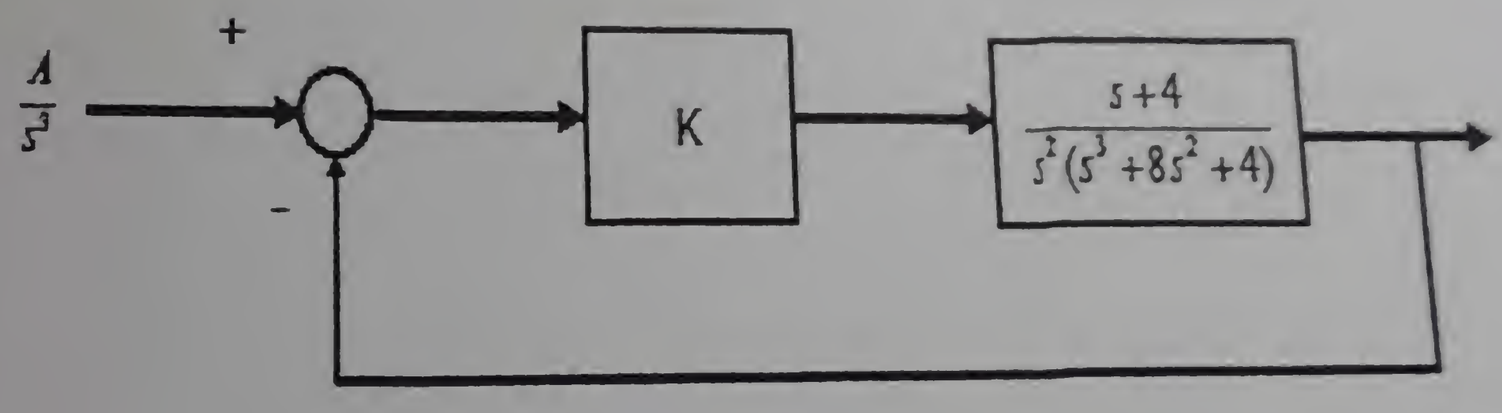


Figure 1

1. For the system in Figure 1, determine: [5 marks]

   a. System type [1 mark]

Type 2 ✓

   b. Appropriate error constant [2 marks]

2- $K_a = \lim_{s \to 0} s^2 = \lim_{s \to 0} s^2 \cdot \frac{K(s+4)}{s^2(s^3+8s^2+4)} = \frac{4K}{4} = K$

3- $e_{ss} = \frac{A}{K_a} = \frac{A}{K}$